## d) Spin Orientation Quantum Number

- An electron has magnetism associated with a property called spin. Magnetism is directional, so the spin of an electron is directional, too. Spin orientation is quantized; Electron spin must be oriented in one of 2 ways, label "up" or "down". The two possible values of $m_s$ are $+\frac{1}{2}$ (up) and $-\frac{1}{2}$ (down)

- Electrons are said to be paired when they are in the same orbital (eg. 2s, $2p_x$, $2p_y$, $2p_z$, $3d_{xy}$ $3d_{xz}$ ·····) and have opposite spins – one has an $m_s = +\frac{1}{2}$ and the other has $m_s = -\frac{1}{2}$.

  * Pauli Exclusion Principle – "No more than two electrons can be assigned to the same orbital in an atom, and these electrons must have opposite spins".

OR. "No two electrons in the same atom can have the same set of four quantum numbers $n$, $l$, $m_l$ and $m_s$"

(11) 3s

$n = 3 \quad l = 0 \quad m_l = 0 \quad m_s = +\frac{1}{2}$

$n = 3 \quad l = 0 \quad m_l = 0 \quad m_s = -\frac{1}{2}$

$n$, $l$ and $m_l$ are same but different $m_s$.

## Problem-Solved Example 30

Give sets of four quantum numbers for three electrons that are

a) in the same level, same sublevel, but in different orbitals.

b) in the same level, but in different sublevels and in different orbitals.

## Solution

Solution: a) level : $n = 2$
sublevel : $\ell = 1$ (p) } different orbitals $2p_x, 2p_y, 2p_z$

three electrons → (1)(1)(1)

$m_\ell$ −1 0 +1

$n=2 \quad \ell=1 \quad m_\ell = -1 \quad m_s = -\frac{1}{2}$

$n=2 \quad \ell=1 \quad m_\ell = 0 \quad m_s = -\frac{1}{2}$

$n=3 \quad \ell=1 \quad m_\ell = +1 \quad m_s = -\frac{1}{2}$

(b) - same level } $n = 2$
- different sublevel } $\ell = 0$ (s sublevel)
$\ell = 1$ (p sublevel)

- different orbitals : $2s, 2p_x, 2p_y, 2p_z$

3 electrons → (↑↓) (1)◯◯

2s 2p

$m_\ell$ 0 −1 0 +1

2s orbital: $n=2 \quad \ell=0 \quad m_\ell = 0 \quad m_s = -\frac{1}{2}$

$n=2 \quad \ell=0 \quad m_\ell = 0 \quad m_s = +\frac{1}{2}$

2p orbital: $n=2 \quad \ell=1 \quad m_\ell = -1 \quad m_s = -\frac{1}{2}$

*Prepared by*
*V. Manoharan*
vmano@usm.my
manovv1955@yahoo.com
04-6533888 ext 3566